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Theoretical Solid State Physics and Statistical Mechanics Group III

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Research Activities

(I) Low Dimensional Systems

a. Coupled Chains of the BGD Model (Y. Suzumura)

The free energy of the charge density wave (CDW) ordered state is calculated in a system of the Coulomb-type interaction between chains with interchain interactions represented by the model of Bychkov, Gor'kov and Dzyaloshinskii (BGD). At low temperatures, the hamiltonian is treated in the self-consistent phonon approximation (SCPA), whereas the hamiltonian is treated in the mean-field approximation (MA) near the second-order phase transition temperature (T_c). The quantum effect is investigated by calculating the order parameter and the specific heat.[1)]

b. Tomonaga-Luttinger Model (Y. Suzumura)

The method of the boson representation is applied to the Tomonaga-Luttinger model to obtain the one-particle temperature Green's function which is derived by Dzyaloshinskii and Larkin. In case $T=0$, the method and the result are essentially same as those of Luther and Peshel. The density of states $D(\omega)$ is calculated in cases both $T=0$ and $T\neq 0$. It is shown that the quantity $D(\omega)$ near $\omega=0$ is proportional to $|\omega|^A$ in case $T=0$ and that the quantity $D(0)$ at low temperatures is proportional to T^A, where the quantity A is related to the strength of the interaction. A sum rule for $D(\omega)$ is derived.[2)]

c. Pinning of the Charge Density Wave (T. Tsuzuki and K. Sasaki)

Two kinds of functions of the impurity are studied for the charge density wave (CDW) in a quasi one-dimensional conductor, by considering the case of a single impurity. We formulate our problem in the selfconsistent field approximation and near the transition point to the CDW state. It is pointed out that the impurity-induced Friedel oscillation of electron density as well as the symmetry-breaking effect of impurity in the usual sence govern the processes of the onset and the pinning of CDW below the transition point.[3,M2)]

(II) Anisotropic Superfluids

a. Angular Momentum (S. Takagi)

We show that a BCS-type ground state with the Anderson-Brinkman-Morel order parameter has a total angular momentum of $\frac{1}{2}N\hbar$ provided that three conditions (axial symmetry, single valuedness, and regularity) are satisfied. Some generalizations of this result as well as a short comparison with other work are also presented.

b. d-Texture in Superfluid ^{3}He (S. Takagi and M. Ashida)

It is theoretically shown that a 'non-singular spin vortex' is able to appear in a thin slab of superfluid ^{3}He-A. It is a localized texture of the spin part of the order parameter and characterized by a topological number. The law of interaction between two vorticies with the same topological number is determined analytically, and the effect of magnetic field is briefly discussed.

c. Stability of Superflow in ^{3}He-A (S. Takagi and K. Kawagoe)

We consider helical textures in toroidal container in the presence of superflow and magnetic field, and find helical textures are developed stably with magnetic field, but become unstable beyond some threshold.

Publications

1) Properties of the CDW Ordered State in Coupled Chains of the BGD Model, Y. Suzumura, Prog. Theor. Phys. 62 (1979), 342
2) The Density of State of the Tomonaga-Luttinger Model, Y. Suzumura, Prog. Theor. Phys. 63 (1980), 51
3) The Charge Density Wave and the Impurity in a Linear Conductor, T. Tsuzuki and K. Sasaki, Solid State Commun. 33 (1980), 1063
4) Angular Momentum of Anisotropic Superfluids, M.G. McClure and S. Takagi, Phys. Rev. Lett. 43 (1979), 596
5) d-texture in Superfluid ^{3}He-A (in Japanese), M. Ashida, Busseiron-Kenkyu 32 (1979), 385

Master Thesis (March 1980)

M1) Stability of Superflow in ^{3}He-A in the Presence of Magnetic Field, Kiyoshi Kawagoe
M2) The Charge Density Wave and the Impurity in One- and Quasi One-Dimensional Conductors, Kazuo Sasaki